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ITS BEARING ON THE THEORY OF
MUSCULAR INSUFFICIENCY.

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DR. A. DUANE,

ASSISTANT SURGEON, NEW YORK OPTHALMIC AND AURAL INSTITUTE.



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PARALYSIS OF THE SUPERIOR RECTUS AND ITS BEARING ON THE THEORY OF MUSCULAR INSUFFICIENCY.¹

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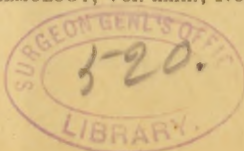
ASSISTANT SURGEON, NEW YORK OPHTHALMIC AND AURAL INSTITUTE.

PARALYSIS of the superior rectus has usually passed for a pretty infrequent affection. Mauthner in his classical work upon *Paralyses of the Ocular Muscles*, states that of 108,000 cases of eye diseases of all sorts, collected by Mooren, there is not a single case of isolated paralysis of the superior rectus recorded, while in Graefe's 40,000 cases there are 9, in Schubert's 20,000 cases 8, and in Schöler's 20,000 cases 3. On the other hand, Hulke out of 19 cases in which the oculomotor nerve was affected found isolated paralysis of the superior rectus in 5. This last result, Mauthner says, is opposed to all our experience, and he adds that one would rather expect to encounter twenty cases of total oculomotor paralysis in succession before meeting with one in which only a single branch of the nerve was affected.

In spite of this dictum from so eminent an authority, I must say that my experience is quite in accord with Hulke's; and, in fact, among the cases that I have examined, isolated paresis of the superior rectus stands next in order to that of the external rectus, surpassing even paralysis of the superior oblique in frequency. I have, that is, in examining a comparatively limited number of unselected cases both in private

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and dispensary practice, seen six in which there was undoubted paresis of the superior rectus unaccompanied by any other form of paralysis, or by any heterophoria not directly attributable to the affection of the superior rectus itself; and I have seen four others in which it was associated respectively with esophoria, insufficiency of the externi, paresis of the internal rectus of the other eye, and a concomitant divergent squint—complications which have obviously no real etiological connection with the condition in question. In addition, I have noted some half dozen other cases in which the muscular conditions were more complex, but in which various circumstances pointed to the part played by the affection of the superior rectus in the production of the attendant symptoms; so that from these and the cases just mentioned, a fairly complete symptomatology can be evolved, together with data regarding the etiology and treatment.

For convenience of inspection I have presented the histories of these cases in the appended tabular form. Before seeking to draw any inferences from them, however, I would like to invite your attention for a few moments to a consideration of the nature and diagnostic features of the condition which we are studying.

The superior rectus is an elevator and adductor of the eye, and rotates the upper extremity of the vertical meridian of the latter inward. Its elevating action is most marked when the eye is abducted; its adducting and rotating actions, on the other hand, increase as the eye is rotated inward. Hence, when this muscle is paralyzed, the eye to which it is attached lags below when the two eyes are lifted up, and owing to the unbalanced action of the other muscles diverges somewhat from its fellow, and undergoes torsion, so that the upper end of its vertical meridian diverges from that of the other eye. Moreover, the deficiency in elevation of the eye is most pronounced in abduction, while the relative divergence and the torsion of the vertical meridian are particularly marked when the eyes are carried inward to the median line and beyond it to the nasal side. Or, vertical diplopia occurs in looking up, which diplopia increases as

the eyes are carried up, and increases particularly in the upper and outer part of the field of fixation. In the very slightest cases, vertical diplopia may occur only in the last-named region; in more pronounced paresis, it will also be present both when the eyes are directed straight upward and when they are abducted in the horizontal plane; and in complete paralysis, it will be marked when the patient is looking straight to the front and will even be apparent for a short distance below the horizontal plane. The diplopia, besides being vertical (with the image which corresponds to the paretic eye higher) is also crossed; and the lateral divergence of the images is greatest when the eye is directed straight forward or when it is somewhat adducted. Both the vertical and the lateral diplopia may vary in amount from two or three to many degrees; and in those parts of the field where, owing to its small amount or to the compensating action of other muscles, the separation of the eyes fails to produce actual diplopia, its presence can be made out by the insufficiency tests, and we hence find a hyperphoria or an exophoria. The exophoria produced by paresis of the superior rectus amounts to three or four degrees even in the slight cases, and is distinguished from ordinary exophoria by the fact that the diverging power (abduction) of the eyes instead of being increased is either normal or slightly diminished.

In typical cases of paralysis of the superior rectus the tilting of the vertical meridian produces an apparent tipping of the false image which is in consequence inclined toward the side of the sound eye. This tipping is never recognized by the patient spontaneously, and, according to Mauthner, can scarcely be said to occur in practice. But its presence was noted in at least five of my cases—in three of them beyond the shadow of a doubt, in the others with reasonable certainty. The curious feature about these cases is that, while theoretically the tilting should have been most pronounced when the affected eye was strongly adducted, it was actually observed mainly when the eye was directed up and very slightly in.

When the paralysis is bilateral—and it was so, at least ap-

parently, in nearly all of the uncomplicated cases which I examined,—the tendency to crossed diplopia is even more marked than in the unilateral variety. On the other hand, the tendency to vertical diplopia in the primary position and when the eyes are carried straight upward, is diminished, or, if the muscles are about equally affected, is altogether absent. It is present, however, quite as before, in the upper and right-hand and the upper and left-hand portions of the field of fixation, and also in extreme abduction in the horizontal plane, so that the diagnosis of the bilateral is quite as easy as that of the unilateral variety. In making repeated examinations of these cases of bilateral paresis, I have noticed that the relative strength of the two paretic muscles seems to vary from time to time, so that in the primary position we sometimes get right hyperphoria, sometimes left hyperphoria, and sometimes absolute freedom from any tendency to vertical insufficiency.

There is no other condition which presents precisely the features just described except an isolated spasm of the inferior oblique. But the unchanging character of the phenomena observed, and the absence of any cause that could produce so unique a variety of a spasm render it extremely improbable that this can really be the sole condition present. Nevertheless, I am strongly inclined to believe that, in the bilateral form of the affection, spasm does play a part and that those cases which appear to be due to paresis of both superior recti are actually cases of paresis of one superior rectus associated with compensatory spasm of the inferior oblique of the same eye. This is probable on *a priori* grounds, since it is likely that in the endeavor to lift both eyes equally when there is paresis of one superior rectus, a specially strong nervous impulse is sent to both elevators of the paretic eye. If now this impulse affects both elevators equally, it would, if sufficiently strong to cause anything like a normal action of the paretic superior rectus, produce actual spasm of the unimpaired inferior oblique. This would in one way be an advantage, as tending to overcome the hyperphoria; but it would cause vertical diplopia in the opposite sense in the upper and inner part of the field of fix-

ation, and would increase the tendency to lateral divergence. This action then would be only partially compensatory.

My chief reason for thinking that this sort of compensation actually takes place is that in these bilateral cases the first examination often shows that the affection is strictly unilateral, while subsequent trials reveal involvement, more or less marked, of both sides. Moreover, as already stated, this secondary involvement is evidently a variable condition, since the effects it produces will in the same case at one time equal, at another time exceed, and at another again fall short of those produced by the primary paresis. This is precisely what we should expect in a case of compensatory spasm which must necessarily be variable in amount.

With this reservation then, that the diagnosis of bilateral paresis is open to question, we may say that the differentiation of these cases is easy, provided that we can establish with certainty the existence of diplopia having the characteristics given above.

The determination of this latter, however, requires the intelligent co-operation of the patient, and may be rendered difficult by his stupidity and inattention or by a perverted imagination which makes him see things as they are not. Hence no diagnosis should be regarded as final unless established by the concordant results of several examinations in which the conditions have been varied so that deception, conscious or unconscious, is impossible. This has been done in all of the cases here reported, and, in nearly all, the examinations have been repeated at intervals of several weeks or months; and no case so examined has been adduced unless the results obtained were uniformly accordant. Moreover, in all these cases the influence of complicating conditions has been taken into account, and wherever possible has been eliminated—*e. g.*, in the case of refractive errors by the use of the proper correcting glass. It is hoped therefore that these cases, few as they are, will suffice to illustrate, with reasonable fulness, the main symptoms attributable to paresis of the superior rectus.

These symptoms appear on the whole to be but slight. The most constant and characteristic is spontaneous diplopia (both lateral and vertical). This is generally transient, but while it lasts causes a disagreeable sense of blurring and confusion. Other symptoms in the order of their frequency are headache, pain, and a sense of weariness in the eyes, and a state of chronic irritation of the conjunctiva and lids which resists local treatment. In one of the uncomplicated cases a variety of scotoma scintillans was present, and the same or a similar phenomenon occurred also in one of the complicated cases. In one or two instances there has been spasm of accommodation, but whether this condition had anything to do with the paresis I cannot say. All the symptoms are aggravated by use of the eyes for close work, and remit when close work is abandoned; and the most frequent complaints came from school-children, musicians, and seamstresses who were obliged by their occupation to look long and steadily at near objects, but in whom no deficiency of accommodation and in most cases no notable error of refraction could be made out to exist.

The way in which the symptoms are produced seems tolerably certain. In the slight cases vertical diplopia is of constant occurrence only in extreme elevation of the eyes or in extreme abduction. Even in more marked paresis the tendency to vertical diplopia in looking straight ahead is slight, and it is absent altogether in convergence and when the eyes are depressed. That is, it is pronounced in those parts of the field of fixation which are practically never used, and is little marked or absent in those positions of the eye which are habitually employed. It is therefore neither a constant nor a very troublesome symptom. This is especially the case in the bilateral form. On the other hand, the exophoria produced by the condition, being quite pronounced when the eyes are directed straight forward and when they are moderately adducted, is constantly present. It is, moreover, particularly marked when the affection is bilateral. Even in slight cases this exophoria amounts to 3° or 4° for the distance, and to an equal or greater quantity for near

points. This is a considerable amount when it has to be overcome constantly, and the exophoria consequently must be the cause of more or less eye-strain, particularly when the eyes are employed for close work, which implies accurate definition of images and consequent necessity for the absence of diplopia.

The other symptoms—headache, pain in the eyes, and conjunctival and palpebral irritation—so far as they are attributable to this condition, are in all probability reflex phenomena due to the strain incurred in overcoming the exophoria.

The causal relation between the paresis and the chief symptoms seems certain. Other causative factors, such as refractive errors, insufficiencies, disorders of accommodation, etc., have been eliminated either by their non-existence or by the fact that their correction had afforded no relief.

In regard to the course pursued by these cases I can present no definite data, as but few of them have been under observation long enough to enable me to speak with certainty upon this point. But in those cases which I have been able to examine at long intervals, the vertical diplopia has remained unchanged in character and apparently also in amount, each examination being in this regard simply a repetition of the one before. The lateral diplopia and the exophoria seem too to be pretty stable factors, not varying much from one time to another, except that there seems to be on the whole a tendency for the exophoria to show a slow progressive increase. It would seem, therefore, that the condition which underlies the diplopia and exophoria must itself be comparatively stationary, and corresponding to this assumption is the fact that the symptoms also show very little alteration, except as they are affected by such disturbing factors as the entrance upon new occupations which throw additional work upon the eyes, or the use of faulty glasses, particularly prisms.

The treatment of these cases may be briefly dismissed. In marked paralysis with a constant vertical diplopia of many

degrees, it will be proper, if we can be sure that the condition is a stationary one, to perform advancement of the paretic muscle. The operation theoretically indicated, namely tenotomy of the inferior oblique of the other eye, is both practically inapplicable and can also be demonstrated to be unsound in principle. Tenotomy of a depressor muscle—inferior rectus or superior oblique—is, of course, out of the question, since it would produce a worse condition than that which it is designed to relieve. Tenotomy of the superior rectus of the other eye may replace the operation of advancement when the paresis is combined with esophoria. It is only a few cases, however, that present symptoms marked enough to justify operative interference of any kind. Only one such has occurred among those that I have examined, and in this advancement of the superior rectus was performed with satisfactory results.

In other cases prisms may be resorted to. Here, as the exophoria is the principal disturbing factor, prisms of two or three degrees before each eye, with base directed inward are indicated. If in addition there is any considerable amount of hyperphoria, a prism base down (or preferably base up) may be employed; but in this case we must recollect that if the glass is to be used for near work (in which the eyes are naturally cast down somewhat), the vertically deviating prism must either be left out altogether or much diminished, because, with the eyes directed even a little below the horizontal line, the tendency to vertical diplopia decreases rapidly and soon disappears. Prisms were employed with quite satisfactory results in three cases; in two others, in which they were prescribed the patients did not get them, and in one case the result of their application was unknown, as the patient did not return.

To supplement muscular deficiencies with prisms, however, is like giving a lame man a crutch; it helps but does not cure his lameness, and in some instances by favoring muscular inaction really retards recovery. A more rational plan, it seems to me, is to exercise the internal recti. This

can be done by systematic practice with prisms placed base out before the eyes. Such exercise, even if it does not increase the actual power of the internal recti, at least enhances the facility with which these muscles work; and whether because of this or because of the stress that is at the same time thrown upon the accommodation, the result of such exercise at all events is that the exophoria diminishes or disappears altogether, at least temporarily.

In many cases the symptoms are too trifling to call for any form of special treatment. The administration of tonics and the enforcement of proper hygienic regulations will fulfil all the therapeutic indications.

A word finally in regard to the etiology of these cases may not be amiss. In the first place they are incontestably much more frequent than they have been supposed to be. Otherwise it is inconceivable that in a small number of unselected cases I should have hit upon so large a proportion in which the superior rectus was the only muscle affected; and while I believe that a more careful examination of all cases will show that paresis of the ocular muscles (particularly of the inferior rectus), is much more frequent than has been supposed, yet the preponderance of instances in which the superior rectus was paretic is still quite remarkable. Moreover, I am convinced from a consideration of the symptoms which they presented that many cases of hyperphoria which I examined before my attention was called to this subject and to the necessity of testing for diplopia in all parts of the field of fixation, were really instances of this affection.

Another noteworthy fact bearing on the etiology is that the affection is one pre-eminently attacking young persons. All the individuals examined were under thirty, and six were under fourteen. The mere statement of the ages at which the affection was observed, however, gives a very inadequate idea of its real prevalence among the young; for not only is there nothing to show in this series of cases that the paresis had developed at or shortly before the time of

observation, but, on the contrary, everything points to its having been in existence an indefinite time. Nay, more, there is nothing to indicate that the condition, in the uncomplicated cases at least, has not been of life-long existence, and in fact I have been led to believe that the paresis is really congenital or at least dates from infancy.

In none of the uncomplicated cases could any cause be assigned to produce the paresis. They have not, for example, been uniformly associated with errors of refraction, such as have been thought to be efficient factors in the causation of these muscular troubles. Four of the cases were practically emmetropic and nearly all the others had a moderate amount of hypermetropic astigmatism. None showed anisometropia of any amount. Only one case presented a large refractive error. In this there was mixed astigmatism of 5.50 D.; and it is rather a noteworthy fact that this was the only case in which there were no symptoms referable to the paresis, which therefore seemed to have occasioned no trouble. This is readily explainable, since the vision which the patient got, $\frac{2}{7}$, did not suffice to produce sharp definition, and hence a slight tendency to diplopia might exist without causing any appreciable addition to the blurring already present. It is a significant fact that it was not till this patient's vision began to improve under glasses that the tendency to compensatory action (evinced by the development of bilateral diplopia) began to be apparent.

Lastly it appears extremely improbable, from the age of these patients and the history which they present, that the paresis can be due to either a nuclear or an orbital lesion of the nerve-twig supplying the superior rectus. I am therefore driven to conclude that the condition in question is the result of a weakness of the muscle itself, due to congenital malformation or, more likely, to arrest of development. When we reflect how little occasion we have, comparatively speaking, to use the superior rectus for making any extensive movements of the eyes, the existence of a species of non-development from non-use seems not improbable.

BEARING OF THESE CASES UPON THE THEORY OF
HETEROPHORIA.

In addition to the interest attaching to the etiology of this condition, it has, it seems to me, an important bearing upon the vexed subject of hyperphoria and indeed of insufficiencies in general. To one who has paid any attention to the problems relating to the muscular defects of the eyes the current theories of insufficiency contain much that is unsatisfactory. The tendency of the eyes to deviate when the temptation to preserve binocular vision is taken away—that tendency which we call insufficiency or by the better term of heterophoria—has been ascribed to various causes. Some write as if the faulty position were due to a want of power in the muscles (insufficiency in the proper sense of the word), and cite under this category cases in which muscles supposed to be weak are actually more powerful than their antagonists. Others regard insufficiency as due to the anatomical disposition of the parts, so that a condition obtains quite analogous to that which occurs in a concomitant squint. Others have signalized the importance of an excess or deficiency of accommodative effort in producing muscular deviations. But no one, it seems to me, has in an adequate and satisfactory way correlated all these different possible causes and pointed out that all or any of them may be operative, and that, just as we have a paralytic squint, a spastic squint, an accommodative squint, and a concomitant squint, so we may have and should distinguish between a heterophoria due respectively to paralysis, spasm, accommodative anomalies, and an excessive relaxation or tension of the muscles induced by faulty anatomical conditions. In emphasizing the difference between heterophoria and strabismus—a difference which, as far as symptoms are concerned, is, of course, most pronounced—we are apt to forget the fact long ago enunciated, that after all heterophoria is latent squint, and that consequently the same means of diagnosis and the same principles of treatment apply to the one as to the other. All of us recognize the fact that the means appropriate for the relief of a paralytic

squint and a concomitant squint are different; and we would not think therefore of attempting to remedy a visible deviation of the eyes without inquiring into the precise nature of the condition producing it. If this is so in the case of a manifest deviation or squint, it should be equally true of a latent deviation, or heterophoria; and my contention therefore is that in the latter condition we shall not employ our tenotomies or our prisms until sure of its precise nature and of its underlying cause. In other words, we must neither consider nor attempt to treat an insufficiency simply as an insufficiency, but must take into account and try to rectify the often complex causes which lie at the root of it. To this end we should, I conceive, in every case of heterophoria, in the first place eliminate the effect of accommodative errors by correcting the refraction; then determine by careful and repeated examinations of the diplopia and the tendency to deviation in the different parts of the field of fixation whether the heterophoria is a concomitant one (*i.e.*, is presumably due to anatomical conditions), or varies in a way to indicate muscular paralysis or spasm. When in this way we have found the cause of the condition and the muscle which is at fault, and are convinced that the condition itself is a stationary and not a variable one, we are ready to rectify the anomaly, supposing always that it still presents symptoms worth rectifying. This seems to me the conservative course, and it is one which I have myself pursued for several years past with very satisfactory results.

In closing I may say that in my own experience parietic heterophoria, of which the condition chosen as my subject is a type, constitutes a fairly large proportion of the total number of cases of insufficiency—a larger proportion certainly than I should have expected to find. They are not, however, nearly as numerous probably as the cases of concomitant (or anatomical) heterophoria in which an eye tends to deviate because one of its muscles is faultily attached and is consequently in a state of undue tension or relaxation. Cases of spasmodic heterophoria are probably not uncommon, occurring much oftener apparently than does true spastic squint. Accommodative heterophoria, although re-

garded by many as the most common variety, is not so in my experience; indeed, it is a rare thing for me to find that the correction of a refractive error, even when kept up persistently for weeks, has influenced at all the muscular balance of the eyes or the heterophoria which is its result.

TABLE OF CASES.

Note.—In preparing this table the following abbreviations, which the writer has employed constantly for the last four years, and which have proved very serviceable in recording cases of muscular trouble, have been used :

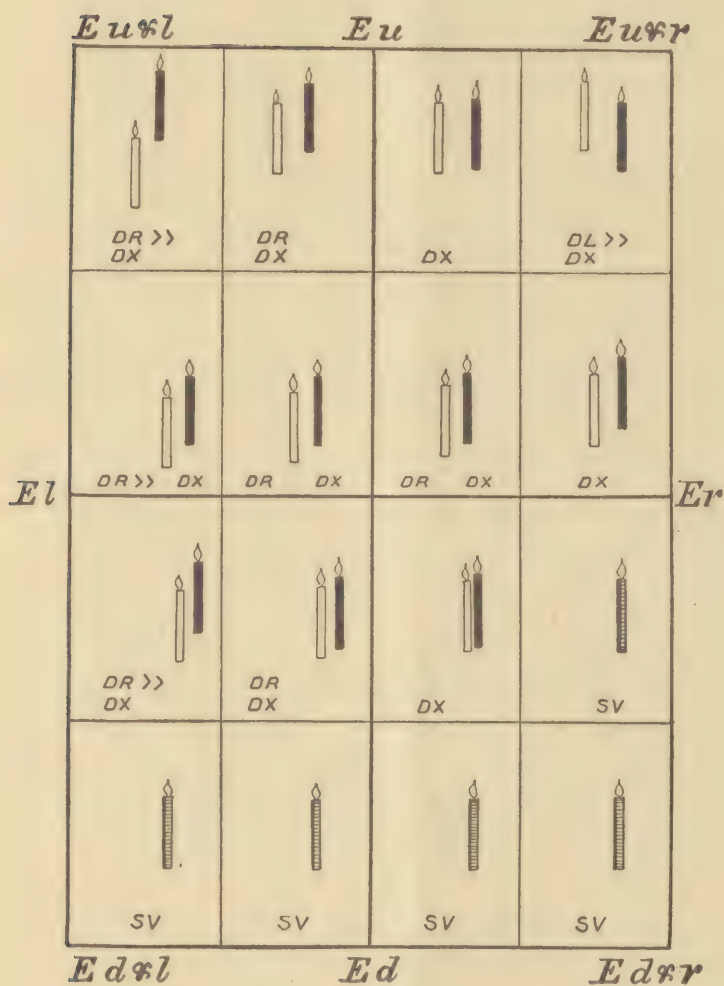
D, diplopia.	Ef, "eyes-front"; both eyes directed horizontally forward.
D', diplopia at near points.	Er, "eyes-right"; both eyes directed horizontally to right.
D//, homonymous diplopia.	El, "eyes-left"; both eyes directed horizontally to left.
DX, crossed diplopia.	Eu, "eyes-up"; both eyes directed up.
DR, "right diplopia"; diplopia with image corresponding to right eye below.	Eu & r, "eyes-up-and-right"; both eyes directed up and to right.
DL, "left diplopia"; diplopia with image corresponding to left eye below.	Eu & l, "eyes-up-and-left"; both eyes directed up and to left.
SV, single vision.	Ed, "eyes-down"; both eyes directed down.
LH, left hyperphoria.	Ed & l, "eyes-down-and-left"; both eyes directed down and to left.
RH, right hyperphoria.	Ed & r, "eyes-down-and-right"; both eyes directed down and to right.
S, esophoria.	>, more than.
S', esophoria at near points.	>>, steadily increasing.
X, exophoria.	<, less than.
X', exophoria at near points.	<<, steadily diminishing.
P//, homonymous parallax. ¹	=, constantly the same.
PX, crossed parallax.	
PR, parallax with image of right eye lower.	
PL, parallax with image of left eye lower.	

Thus the formula for marked paresis of right superior rectus would be :

Ef, DL & X or LH & X, PL and PX. Er, DL (or LH) >>. El, DX.
Eu, DL & X >>. Eu & r, DL >>, DX <<. Eu & l, DL << to SV.
Ed, Ed & l, Ed & r, SV.

The characteristic feature, however, is contained in the expression Eu & r, DL >>, which alone is sufficient to make out the presence of the condition.

¹ By parallax is meant a change in the apparent position of the object of fixation when a screen is shifted from one eye to the other. If, for example, the patient fixes his gaze upon a mark made upon a flat surface (so that the mark cannot be projected upon any plane behind it), and upon carrying the screen from the right eye to the left this mark appears to move to the right, the patient is said to have homonymous parallax (P//); if it moves to the left, he has crossed parallax (PX); if it moves down, he has right parallax (PR); if it moves up, he has left parallax (PL). Parallax in this sense is only diplopia obtained by a special artifice, and, like any other form of diplopia, can be measured in terms of the prism which causes its abolition.



This Diagram represents a case of paresis of both Superior Recti, the muscle of the left eye being the one mainly affected; or a paresis of the left Superior Rectus with spasm of the left Inferior Oblique. Red glass placed before left eye. Nomenclature as upon preceding page.

I.—UNCOMPLICATED CASES.

No.	DATE WHEN FIRST SEEN.	NAME AND OCCUPATION.	AGE.	SEX.	MUSCLE AFFECTED.	OTHER MUSCULAR AFFECTIONS.	RESULTING HETEROPHORIA AND DIPLOPIA.	REFRACTION.	SYMPTOMS.	TREATMENT.	COURSE AND RESULTS.	DATE WHEN LAST SEEN.
1	Nov. 5, 1891.	H. F., school-boy.	12	M.	Both, especially L.	None.	<i>For distance.</i> PX, slight. PR and PL on alternate days. X, 0° (increasing on final test to 2°-3°). LH, 1°-2° (by abducting-prism test). Abd. 6° (finally only 4°). Ad. examination (test of Feb., 1894) less than 15° even at near points. Eu, DR > > rapidly. <i>For near.</i> X, 5' or 6'. Eu, DR > > and DX. Eu & L, DR > > (very rapidly). DX. Eu & r, DL, DX. Er, DX. El, DX marked, DR. Tilting of one or both images frequently observed.	Hypermetropic astigmatism. [Using for reading + 0.75 D. cyl. each, pre-scribed after examination (test of Feb., 1894) under atropine. Glasses given by another oculist 6 or 7 months before].	Severe daily protracted headaches coming on whenever eyes are used for any purpose requiring fixed attention. Somewhat less with andexophoria combined was so much improved as to be able to work all day. Headaches not entirely relieved and afterwards seemed to return, when they were again relieved by astigmatic glasses given by another practitioner. Hyperphoria had in the meantime diminished, so that now prismatic glasses overcorrect this element.	Tentative of great relief of headache, blurring, and asthenopia. By use of prisms and cylinders combined was so much improved as to be able to work all day. Headaches not entirely relieved and afterwards seemed to return, when they were again relieved by astigmatic glasses given by another practitioner. Hyperphoria had in the meantime diminished, so that now prismatic glasses overcorrect this element.	Prisms alone caused great relief of headache, blurring, and asthenopia. By use of prisms and cylinders combined was so much improved as to be able to work all day. Headaches not entirely relieved and afterwards seemed to return, when they were again relieved by astigmatic glasses given by another practitioner. Hyperphoria had in the meantime diminished, so that now prismatic glasses overcorrect this element.	Feb. 17, 1894.
2	Feb. 18, 1893.	B. A., school-girl.	9	F.	Both, in almost equal degree.	None.	<i>For distance.</i> X at first only 3°, afterward increasing to 8° or more. With red glass, DX changing slightly in Er and El. Abd. 8° —, but after using prisms increased to 10°. Adduction (at distance) especially after wearing prisms almost 0°, and very hard to train. <i>For near.</i> X', 6° or more; increasing to 15° after constant use of prismatic glasses. { Eu, DX. { Eu & r, DX and DL > > . { Eu & l, DX and DR > > . { Ed, SV. [Numerous examinations gave absolutely con-	Right eye emmetropic; Left eye slightly hypermetropic (+ 0.50 D). [Examination under hooding.] Conjunctival irritation and pain and lachrymation; not improved by local astringent treatment. Occasional lateral and vertical diplopia. No headaches. Symptomatic aggravated by schoolwork, and occurring chiefly when eyes are engaged in close work; remit at other times and absent during vacation. Afterwards, when exophoria had notably increased, symptoms more marked when using eyes for distance.	Prisms (3° base in and 2° base in) relieved cause marked relief of symptoms; when prescribed for near distance also, aggravated symptoms finally relieved completely by exercise of adduction with prisms; X finally 0° and X', 2°-3° only.	Prisms, when used for near work only, seemed to cause marked relief of symptoms; when prescribed for near distance also, aggravated symptoms finally relieved completely by exercise of adduction with prisms; X finally 0° and X', 2°-3° only.	March 12, 1894.	

3	June 29, 1893.	G. M., seamstress.	26	F.	Both.	—	cortant results, except that first record taken does not reveal any involvement of K. superior rectus]. Final examination shows DX in Ed. <i>For distance.</i> X, 5°. <i>For near.</i> X, 8°. Ef. DX (diminishing slightly in Ed). Eu, DX. Eu & r, DX and DL > >. Eu & l, DX and DR > >. Ed, DX but vertical diplopia slight or uncertain. [Repeated examinations on two separate days by different observers.]	Slight hypermetropia (+ 0.50 sph. accepted). After a moment's looking at any object (especially when doing fine work), object blurs and each becomes double. (Glass of + 0.50 sph. does not prevent this). At other times a spot followed by a light cloud floats before the sight, or she has a sudden attack of amaurosis. These attacks followed by headache. Seeswell on first waking up, but later in day troubles come on.	(Given 2° symptoms had in the eye. in main disappeared upon her giving up her work as a seamstress. Reported by letter, Feb. 18, 1894.
4	Sept., 1893.	H. G., cutter.	28	M.	R. (afterwards of l. also).	None.	<i>For distance.</i> X, 2° +. LH only a trace after affection had become bilateral). Adduction, 15° (with great difficulty). <i>For near.</i> X', 3° +. Eu & r, DL > >. No other vertical diplopia at first examination. At second examination, showed also, Eu & l, DR > >. Eu, DX. No other diplopia. [Examinations on 3 separate occasions several weeks apart.]	Right eye: Pain and irritation of emmetropic; eyes and conjunctival Left eye myo-discharge, especially in base of pic (— 0.50 evening. Not relieved each to use which he had done a sph. under by astrigent treatment, if homatropine). Sense of straining in eyes. Headaches now and then.	(Given 2° symptoms disappeared Feb. 23, 1894. in giving up reading, of sym- good deal; hence did not use prisms.

No.	DATE WHEN FIRST SEEN.	NAME AND OCCUPATION.	AGE.	SEX.	MUSCLE AFFECTED.	OTHER MUSCULAR AFFECTIONS.	RESULTING HETEROPIORIA AND DIPLOPIA.	REFRACTION.	SYMPTOMS.	TREATMENT.	COURSE AND RESULTS.	DATE WHEN LAST SEEN.
5	Nov. 11, 1893.	C. U., school-girl.	12	F.	R. (mainly).	None.	PX, 2° + ; PL, decided. X, 0-3, L.H. 0-1. <i>For near.</i> Eu & r, DL and DX. Eu (extreme), DX. Eu & l, DX. Er, tendency to DL. El (extreme), DX. No diplopia elsewhere except in final examination, when slight DR in Eu & l (compensatory action of inferior oblique) was observed. [7 or 8 examinations made on 4 different days.]	Mixed astig. (cyl. + 5.50 D with sph. - 2.00). [Examination under homatropine.]	Symptoms mainly those due to error of refraction—poor vision and occasional headaches.	Correction of refractive error.	Gradual improvement of sight under use of glasses, V when last tested 30.	—
6	Nov. 17, 1893.	M. B.	9	F.	R.	None.	<i>For distance.</i> PX (= 2°) and PL. X, 3°. L.H. slight. Abd. 5°. <i>For near.</i> Eu & r, DL. No diplopia elsewhere.	Emmetropia and V normal. [Examination under homatropine.] Accommodation normal.	Pain in eyes and almost constant frontal headaches for each past 2 months. Can not see well to read, and even at distance objects blur. Had scarlet fever in May, and to this mother attributes present trouble, but symptoms did not begin directly after illness.	Given prism base in return.	Did not return.	

II.—CASES COMPLICATED ONLY WITH A LATERAL DEVIATION.

7	Dec. 27, 1889.	J. T. R.	20	M.	R.	Insufficiency of left internal rectus (? or spasm of right	<i>For distance.</i> Eyes diverge behind screen. PL, 4-5°. PX, 12°. X very variable. LH 2-6°. of right Abd. 22°.	Hypermetropic astigmatism. { R. + 1.00 sph. - + 0.75 cyl. - L. + 0.75 sph. - + 0.75 cyl. }	Very severe headache at times. Used to have diplopia superior when young, and this right eye diverged more than prior	Advance-ment right of opera- tor. Report of let- tice-rector by di- mite left supe- rior ver- tical di- ter, for Feb.	Final result! April, 1890.
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8 Aug. 23, 1890.	L. H. II	F.	L.	Insufficiency of both external, especially L.	Adduction, 11°-15°. Excursion test practically same as for near objects. Produces voluntary DX by turning out right eye. <i>For near.</i> Eu & r, DX >>, DL >>. Eu & l, DL << to SV, DX <<. Er, DX and DL, PX >>. El, PX << to 0°. Image formed by right eye tilted to left.	under atropine. Developed spasm read with right eye of accommodation alone. after use of correcting glasses.	at present. Cannot advance-ment right eye with accommodation alone. (Correction position of astigma-conver-tism. Exercise of phoria con-verted into slight eso-phoria (about 1°). Adduction 38°. Head-aches relieved by glasses Can now use right eye for reading, and vision in it has improv-ed (report of Feb., 1894).	looking di-rectly for-ward and for position of gen-eral; exo-phoria con-verted into slight eso-phoria (about 1°).	25.
8 Aug. 23, 1890.	L. H. II	F.	L.	<i>For distance.</i> D// and DR (inconstant). D// >> laterally, especially in El. DR >> in El. P// and PR. S, 7°-20°. RH, slight or 0° (by abducting prisms). Abd. 5°-8°. Both eyes deviate markedly in behind the screen. <i>For near.</i> Eu, D// and DR. Eu & l, DR >> and D//. El, D// and DR. Er, Eu & r, Ed, no diplopia. [Numerous examinations made on four or five separate days.]	Hypermetropia and astigmatism. R. + 2.50 sph. + 0.75 cyl. L. + 2.00 sph. + 0.50 cyl. [Examination under atropine.] Examination under sph. - + 0.75 cyl.; verging L. + 1.50 sph. - prism. + 0.50 cyl.). Six months ago attack of diptheria followed by paresis of laryn-geal and some trunk-muscles and strabis-mus. Sight became blurred, and she de-veloped spasm of accommodation.	In Jan., 1880, first treated for astheno-mopia troubles (pain in eyes, difficulty in reading, etc.). Given glasses (R. + 2.00 with con-vergence squint.	Advance-ment both complete of conver-gent squint.	Nearly Jan. 30, 1891.	

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9	Aug. 27, 1892.	S. M. C.	25	F.	R. (afterwards of both).	Esophoria (? accommodative).	<i>For distance.</i> P 0° or L and $\frac{1}{2}$. S, 3 or more (less with refraction corrected; greatest when eyes are under influence of homatropine and refraction is uncorrected). L.H. 1 -2 (by diverging-prism test); at times 0° (especially when refraction is corrected), and then S less. At last examination, R.H. 1°. Abd. 5°-6°. Adduction, 20° easily. D// in E.I., not in E.r. <i>For near.</i> S several degrees (0° with glass). Eu & r, D.L. At last examination also showed, Eu & l, DR and D//. Eu, D//. Ed, SV everywhere. [Several examinations at long intervals.]	Hypermetropia and astigmatism.	Daily headaches (frontal), and pain of referred to back of eye error. Given temporarily by use of R. + 0.50 sph. glasses, but recur-sph. Cannot use + 0.50 accommodative spasm; eyes for near work + 0.50.	Correction of refrac-tive error. Given R. + 0.50 L. + 0.75 for fa-sph. constant	Prisms caused no relief.	Mar. 31, 1894.
10	March 20, 1893.	T. K.	13	M.	Both, especially L.	Divergent strabismus.	<i>For distance.</i> Eyes diverge markedly, producing regular diplopia. Has been usually using a glass of + 1.00 each. For 6 years has been affects R. eye. Eyes diverge behind screen, 0.75 for both far and in the habit of closing and in making movement of redress, eyes near, prescribed right eye when (especially right) shoot beyond the mark, and Nov., 1890. Used he wishes to see at a then return by jerky motion to position of these for a year and distance. Screws up eyes when he reads; eyes get tired and pain him after reading. Headaches rare. <i>For near.</i> Converges normally, but with much effort, and has binocular fusion near point of 3 inches. Ef, DX (with red glass) and DR or sometimes DL. Eu & l, DR > >. Eu & r, DL > >. No diplopia in Ed. [Several examinations.]	Emmetropic. V. $\frac{1}{8}$ each. Has been taneous diplopia. Using a glass of + 1.00 for 6 years has been in the habit of closing prescribed right eye when Nov., 1890. Used he wishes to see at a then stopped.	None.	Symptoms remained the same during the 11 months when he was under observation.	Feb. 17, 1894.	

III.—CASES COMPLICATED WITH OTHER VERTICAL DEVIATIONS.

11	March 1886.	A. D., physician.	27	M.	L. : (afterwards R. (traumatic).)	Esophoria : lately has shown involvement of depressors of eye.	<i>For distance.</i> RH, $1^{\circ}-2^{\circ}$; S, $2^{\circ}-3^{\circ}$. Abd., 3°. Adduction at first very limited. Since operations—hyperphoria^o or only a trace. Diplopia for distance same as for near, except that in Ef gets sometimes D//, sometimes DX, and the normal tendency, unless the eyes have been used for near work, is to D// in Ef ; and the D// in Er is marked for distance and increasing. <i>For near.</i> X' $2^{\circ}-3^{\circ}$. Ef, SV. Er, D// slight, DL slight. El, DX marked, DR. Eu & I, DX >> greatly, DR >> (marked.) Eu & r, DX >> slightly. DL >>. Ed, D// >>. Ed & r, DR and //. Ed & l, DL slight. In Eu tilting of image formed by right eye.	Hypermetropic astigmatism developing into mixed astigmatism (+ 2.25 and + 1.75 D. cyl. with drawing of eyes tenotomies — 1.00 sph.). Severe periodical attacks of migraine (infrequent). Sense rectus and the hyperphoria by a prism before the tenotomies were done caused of refracted re-tion (after relief of sym-first series tons. Tenotomies produced sim-lar relief, although not an absolute one.	Tenotomy R. superior rectus and the hyperphoria by a prism before the tenotomies were done caused of refracted re-tion (after relief of sym-first series tons. Tenotomies produced sim-lar relief, although not an absolute one.	Partial correction of hyperphoria by a prism before the tenotomies were done caused of refracted re-tion (after relief of sym-first series tons. Tenotomies produced sim-lar relief, although not an absolute one.	Feb., 1894.
12	Dec. 11, 1890.	F. T. C., college tutor.	28	M.	R. (slight consecutive affection of right inferior of L), norrectus.	Insufficiency of right inferior of L, norrectus.	PX and PL. DX and L in Ef. X, 4° (later 7°). LH, $1^{\circ}-2^{\circ}$. Abd. 8°. Adduction at first small, afterwards readily performed. <i>For near.</i> X' many degrees. Ef, DX and alternately DR and DL. Eu, DL >> and DX >>. Eu & r, DL >>. Eu & l, DR >> (but not marked). Ed, DX >> and DL, changing to DR. Ed & r, DR >>. Ed & l, DR << to SV, then DL. On final test shows tipping of both images in Eu & l.	Myopic astigmatism (— 0.25 D. cyl. axis nearly horizontal). [Examination under times, and also produced by voluntary relaxation of interni. Headaches on doing close work. Blepharitis for many years.	Correction of refractive error. Local treatment and blepharitis by glasses ; blepharitis recurs when eyes are used much for near work, and head-aches recur if glasses are laid aside. Exophoria has evidently increased during time of observation.	Headaches relieved completely by glasses ; blepharitis recurs when eyes are used much for near work, and head-aches recur if glasses are laid aside. Exophoria has evidently increased during time of observation.	Feb. 15, 1894.

¹ The interest in this case lies in the fact that it has been under observation for such a long period (8 years), during which the involvement of the left superior rectus and the condition produced by tenotomy of the right have remained essentially the same, as shown by the eyes staying on the same level. It is also of interest as showing how much relief may sometimes be given by prisms, and how the signs of a traumatic paresis are precisely those of the non-traumatic variety.

² Hyperphoria was, according to the testimony of a competent observer, present at least two years before my first examination.

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13	Oct. 17, 1891.	N. A., school-boy.	13	M.	Both (especially R).	Insufficiency of both inferior recti (especially left), and esophoria.	<i>For distance.</i> P// and P.L. L.H., 2°-3°. S, 2°-5°. Ald. 4°. Eu & r, DL > >, D// slight. Eu & l, DR slight. Eu, DL. El, D// > >. Er, D// > >. Ed, D// > >. Ed & l, DL > >, D//. Ed & r, DR and D// > >. <i>For near.</i> Diplopia as for distance, except that in Eu & l, gets no diplopia.	Hypermetropia (R. + 0.75 sph. L. + 0.75 sph. + 0.25 cyl. 90°).	Ever since measles, 2 years ago, right eye aches and burns when used for near work. Can read well if R. eye is closed, but not if L. eye is closed. Conjunctival congestion.	Astringent collyrium.	Marked improvement, although he ports reads a good deal eyes in 1893 still aches, indicate that improvement has continued.	Dec. 31, 1891. (Records received eyes in 1893)
14	Feb. 28, 1893.	E. S., school-girl.	8	F.	Both.	Insufficiency of both superior oblique (coming on later).	<i>For distance.</i> X, 3°-4° (afterwards less). No hyperphoria, but later on gets RH with diverging prism and LH with converging prism. P.L. very slight. <i>For near.</i> S, 2°-3°. Eu & l, DR. Eu & R, DL. At first examination no other diplopia. [Repeated examinations.] Afterwards (Dec., '93) shows same and also : Ef, DL (inconstant). Ed & R, DL.	Hypermetropia of + 0.50 D shown under homatropine. V. normal.	Constant headaches over and between eyes (dated from injury received 3 months before—blow upon head from falling down stairs—but had had the same sort of headaches before). In later examination (Dec., '93) also states that she has pain in eyes; has to group close to objects to see them.	None.	Symptoms same.	Dec. 23, 1893.

						Ed & I, DR. And in Eu, image of L. eye tilted to R. Ed, image of L. eye tilted to L. (?)		has occasional spontaneous vertical diplopia; sometimes red or blue lights come before eyes, clouding the sight. At times stands still and shakes				
15	June, 1893.	B. S.	28	F.	Both.	Esophoria. Insufficiency of left inferior rectus (developing later).	<i>For distance.</i> S, 1°-2°. Abd. 6°. Hyperphoria 0° or LH 1° (on one examination). <i>For near.</i> S, slight. Eu & I, DL > > and DX. Eu & I, DR > > and DX. Ed, no diplopia. [Several tests]. Examination, Feb. 17, '94, shows also Ed & I, DL.	Hypermetropic astigmatism (+ 0.75 sph. $\ominus$ + 0.50 cyl. R. E., and + 0.75 sph. $\ominus$ + 0.75 cyl. L. E.) Given R. + 0.50 cyl. axis 20°. L. + 0.75 cyl. axis 160°. With screw up eyes to see these, V. $\frac{1}{16}$ +. [Examination of refraction made under homatropine.]	Astigmatism corrected by glasses.	Headaches (frontal) frequent, coming on especially in morning, and associated with pains in eyes. In a bright light has to strain and screw up eyes to see well.	Astigmatism corrected by glasses.	Headaches Feb. 17, 1894.

SUMMARY OF SYMPTOMS.

	Uncomplicated Cases.	Cases Complicated with Lateral Deviation.	Cases Complicated with Vertical Deviation.
Spontaneous diplopia.....	1, 2, 3	7, 10	12, 14
Blurring of sight.....	1, 3, 6	—	—
Pain in eyes....	1, 6	9, 10	13, 15
Conjunctival irritation	2, 4	—	12, 13
Fatigue and sense of strain in using eyes.....	1, 4	9, 10	11, 15
Headache.....	1, 3, 4, 6	7, 9	11, 14, 15 ¹
Scotoma scintillans.....	3	—	14
Spasm of accommodation.....	—	7, 8	13
Transient hemianopsia.....	1	—	—
Inability to use the affected eye for reading.....	—	7	13

SUMMARY OF TREATMENT.

	Case.	Result.
Advancement superior rectus.....	7	Improved.
Exercise of adduction.....	2	Relieved.
	7	Improved.
Application of prisms for exophoria and hyperphoria.....	1	{ Improved temporarily.
	2	
	11	
	6	
		{ Result unknown.
	3	
	4	{ Did not wear glass prescribed.
Local astringent treatment.....	2, 4, 12	Ineffectual.
	13	Caused improvement.

¹ Also in 12, but here apparently due to another cause.

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